INFOSHEET # 3

On-Farm Nutrients & Greenhouse Gas Reduction Opportunities for Ontario Agriculture

Ontario

The gradual warming of Earth's temperature is largely attributable to excessive greenhouse gas (GHG) emissions. These emissions are both natural and unnatural byproducts of industrial, transportation, urban and agricultural activities. It will take concerted and sustained efforts by all these sectors to reverse the trend of rising GHG levels.

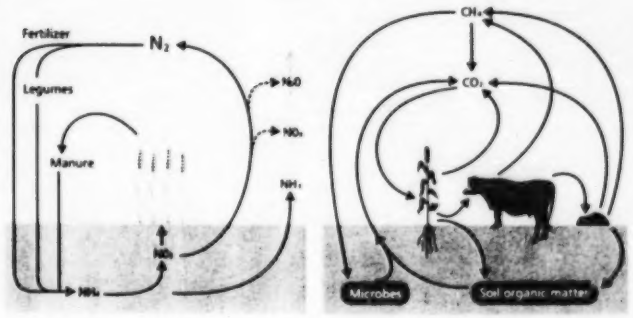
The implications of climate change can be overwhelming. Many of Ontario's farmers have felt its effect first-hand with changing weather patterns. But there are practical on-farm measures that reduce GHGs and promote long-term soil productivity and water quality, reduce input costs, and generally add to the environmental integrity and safety of their operations.

In agricultural enterprises, the GHGs of most concern are **nitrous oxide (N_2O), methane (CH_4),** and **carbon dioxide (CO_2)**. While nitrous oxide is by far the most potent GHG (310 times more potent than carbon dioxide), it also presents farmers with the greatest range of opportunities for GHG reduction.

Nitrogen and carbon cycles

As nutrients, nitrogen and carbon are indispensable agents for promoting crop growth and soil health. Depending on how they're managed, nitrogen and carbon can also be significant sources of emissions.

As nitrogen cycles through the environment, some of it will be released as nitrous oxide. Carbon also cycles through the environment, and can become either methane or carbon dioxide.



N_2O can be produced directly from decomposing manure – in storage and on the field. It can also be produced indirectly. Large amounts of N are lost as NH_3 when manure is exposed to air, either on the barn floor or in the field. Part of this ammonia can be converted to N_2O. Indirect losses also result from runoff to surface and ground water systems.

N_2O is produced in cropland soils as well. **Denitrification** – or the conversion of plant-available nitrogen to nitrogen gases (including N_2O) – is caused by soil microbes in moist soils. Limiting excess available nitrogen in soils at any time is a key factor in limiting denitrification.

Carbon, in the forms of CH_4 and CO_2, is released by ruminants, decomposing manure, and decomposing soil organic matter. These losses can be reduced through animal genetics and feeding strategies, as well as improved manure handling and storage techniques.

While these processes are in part unavoidable byproducts of food production, the proportion of nutrients that enters the atmosphere as GHGs can be reduced by adopting on-farm nutrient management planning and practices.

GLOSSARY

BMP	best management practice	**NH_3**	ammonia
C	carbon	**NH_4**	ammonium
CH_4	methane	**NO_x**	nitrogen oxide gases
CO_2	carbon dioxide	**N_2O**	nitrous oxide
GHGs	greenhouse gases	**NO_3**	nitrate
N	nitrogen	**SOC**	soil organic carbon
N_2	nitrogen gas		

MAJOR NUTRIENT-RELATED GREENHOUSE GAS SOURCES

SOURCE	PROBLEM	N_2O 310:1*	CH_4 21:1*	CO_2 1:1*
FIELD	• oversupply of fertilizer/manure	✓		–
	• no or delayed incorporation	✓		
	• winter/fall application of manure	✓		
	• inappropriate timing of inorganic fertilizer application	✓		
ANIMAL	• ruminant emissions		✓	✓
	• decomposition of manure on pasture	✓		
MANURE	• decomposition during handling	✓	✓	✓
	• decomposition during storage	✓	✓	✓
Percentage of direct farm emissions as % of total CO_2 equivalents		55%	33%	12%

*global warming potential, i.e., N_2O is 310 times more potent than CO_2.
Source: "Greenhouse Gas Emissions and Economic Model for Ontario (GEEMO)." Thomsen Corporation Report to OMAFRA, 2000

GHGs & Livestock Feeding

Approximately 40% of GHGs in the farming sector originate from livestock – half as methane production from ruminant digestion and the rest from decomposing manure. Improvements in feeding can decrease the amount of nitrogen in manure and reduce methane and carbon dioxide production by livestock.

While much is still at the research stage, advances are being made in areas such as:

- improved animal genetics and feed conversion
- improved feed through plant genetics, improved processing, or amino acid supplements to better meet animal requirements
- ionophores (feed additives that reduce methane production), and other supplements to improve feed efficiency
- lower nitrogen fertilizer use, reducing excess nitrogen content in pasture and other feeds.

GHGs & Nutrient Management Planning

Nutrient management planning focuses on supplying only those nutrients necessary to optimize profit, and maintaining nutrients in the soil until they're required by crops.

In devising a nutrient management plan, all nutrient sources must be accounted for, including soil fertility reserves, manure nutrients, and previous crop residue nutrients. Only then can the amount of fertilizer required for crops be calculated.

Areas of nutrient management that have implications for GHGs include:

- **manure storage and handling**
- **soil and manure testing, and**
- **nutrient application.**

The rest of this infosheet sets out BMPs that minimize nutrient loss and thus help reduce GHG emissions that can result from these key activities.

MANURE STORAGE & HANDLING

Rapid removal of manure from the barn floor to a covered storage area and maintenance of clean, dry facilities reduce the amount of ammonia lost – which in turn reduces the production of nitrous oxide.

Methane is the GHG given off in the largest quantities in manure storage systems, especially in low oxygen conditions found in liquid manure tanks.

MANURE HANDLING & STORAGE AND GHG REDUCTION

BEST MANAGEMENT PRACTICE	RATIONALE
MANURE HANDLING	
• contain all runoff	• reduces NH_3 loss, retains nutrients for crops, and prevents water pollution
• remove manure from barn floor promptly	
MANURE STORAGE	
• use covered storage (roofs for solid; covered tanks for liquid)	• prevents direct losses of N_2O and CH_4 to the air
• use bottom-filling tanks	• reduces loss of CH_4 to air
• maintain low temperatures with below-ground tanks, and reduce summer storage with late-summer application	• limits the biological activities that produce CH_4 and N_2O
• keep poultry manure dry	• produces fewer GHGs than wet manure

SOIL & MANURE TESTING

Fertilizer recommendations should be based on soil and manure tests. This will reduce the loss of plant-available nitrogen and the production of nitrous oxides.

1. Test manure regularly to account for manure nutrients.
2. Test soils to determine fertility levels.
3. Use the soil nitrate test to help minimize excess soil nitrogen levels.
4. Use cover crops to "catch and release" available soil nitrogen.
5. Account for the N credit from previous and cover crops (e.g., legumes).

Crop choices also affect the nutrient requirement. Corn, for example, requires much more N than cereal grains. N-testing and application need to be geared to the crop.

FERTILIZER APPLICATION AND GHG REDUCTION

BEST MANAGEMENT PRACTICE	RATIONALE
FIELD APPLICATION OF MANURE	
• incorporate immediately (within one day)	• reduces losses of NH_3 and indirect N_2O
• reduce late fall and winter application	• prevents runoff and spring N_2O losses
• apply according to plant requirements	• allows N to be used by plants, rather than being lost to the air
• calibrate spreader and apply uniformly	• avoids excess nutrient supply to the crops (spots of high N concentrations will result in N_2O production)
• monitor tile drains during application of liquid manure	• reduces runoff to surface tile drains (limits N_2O production and surface water contamination)
FIELD APPLICATION OF INORGANIC FERTILIZER	
• sidedress fertilizer	• applies fertilizer where and when the plants need it
• use slow-release fertilizers	• makes N available to the crop when it's required
• use urease and nitrification inhibitors	• reduces the loss of N_2O (NB: more research required)
• use site-specific practices (e.g., variable rate technology)	• makes fertilizer available where and when it's required

ESTIMATED EFFECTS OF MANAGEMENT PRACTICES ON ONTARIO AGRICULTURAL GHG PRODUCTION

Management Practice*	GHG Reduction (CO_2 equivalent kt/yr)	Relative Ranking for GHG Reduction
• reduce recommended N use on corn by 5%	46	low
• reduce recommended N use on corn by 15%	140	medium
• use N soil test (100% of farms)	288	high
• use available manure N for crop production	650	very high

*Figures assume 100% compliance by Ontario agricultural sector

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NUTRIENT APPLICATIONS

Timing is almost everything when applying and incorporating manure and inorganic fertilizer – do so only when they will be used by crops. In the absence of plant uptake, significant losses will occur through runoff, leaching, and the atmosphere. Also, the nutrient value of the fertilizers applied will be reduced.

Challenges

Current challenges relate to developing cost-effective systems for good nutrient management. These include:

- no-till systems – equipment is expensive
- manure storage cover systems – effective ones are expensive
- increased soil and manure testing.

Research needs

- responsiveness of animal conversion efficiencies with genetics, enzymes and amino acids, and matching plant nutrient balances to animal requirements
- accurate assessment of longer-term, whole-farm GHG balances, including manure management, nutrient management planning, soil types and crop rotations
- studies to show increased profitability of improved nutrient management planning

This is the third of a four-part series that addresses greenhouse gas emissions and their implications for Ontario farmers. Infosheets #1, #2 and #4 address, respectively:

1. **greenhouse gases – what they are, how they contribute to climate change, and what challenges and opportunities lie ahead for Ontario farmers**
2. **carbon sequestration – how agriculture contributes to carbon dioxide gas emissions, and which on-farm practices can reduce them by retaining or "sequestering" beneficial carbon as soil organic carbon**
4. **on-farm case studies.**

All four will be available by spring 2001 at select locations, and accessible through the Ministry of Agriculture, Food and Rural Affairs web site at:
www.gov.on.ca/OMAFRA/english/policy/Climate%20Change/Index.html

Funding for this series of Greenhouse Gas infosheets has been provided by the Ontario Climate Change Fund.

The Greenhouse Gas infosheets are a project of the Ministry of Agriculture, Food and Rural Affairs.

For more information, call the Ministry of Agriculture, Food and Rural Affairs, Agricultural Information Contact Centre at 1-877-424-1300, or e-mail: ag.info@omafra.gov.on.ca

Where to go for more information

For farmers and rural landowners

Agriculture and Agri-Food Canada, 1998. Health of Our Air: Towards sustainable agriculture in Canada
- (on the web at: www.agr.ca/research/branch)

Best Management Practices series of books, including: *Farm Forestry and Habitat Management, Field Crop Production, No-till: Making it Work, Nutrient Management, Nutrient Management Planning* and *Soil Management*

Publications of the Ministry of Agriculture, Food and Rural Affairs: *Agronomy Guide for Field Crops* (pending); *The Soil Fertility Handbook*

- available by calling 1-888-4-OMAFRA (1-888-466-2372) or e-mail your request to products@omafra.gov.on.ca or visit OMAFRA's web site at www.gov.on.ca/omafra

Technical/scientific sources

Agriculture and Agri-Food Canada. "Reducing GHG Emissions from Canadian Agriculture," Options Report, January 2000

Documentation of the Ontario Greenhouse Gas Emission sub-model (OGGEM). "A component of the GHG emission and economic model of Ontario," May 2000

The Thomsen Group 2000. "Study No. 3, Ontario Greenhouse Gas Emissions," 2000

Soil Resources Group. "Ministry Management Practices and their Effect on GHG Emissions in the Ontario Agricultural Sector." Final report for OMAFRA, 2000

Key web sites

Multimedia overviews of climate change, and links to GHG calculators
http://www.climatechange.gc.ca

Your link to OMAFRA's Climate Change resources
http://www.gov.on.ca/OMAFRA/english/policy/Climate%20Change/Index.html

Web site for National Climate Change Process. Available documents include: "Canada's First National Climate Change Business Plan," and "Ontario – Air Quality and Climate Change: Insights, Opportunities and Solutions"
http://www.nccp.ca

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